



# Challenges Facing Increased Production and Use of Domestic Natural Gas

Prepared For:

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***Unconventional Resources • Enhanced Recovery • Carbon Sequestration***



**Advanced Resources  
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# Background



The domestic natural gas supply base is diverse and abundant - - with theoretically producible resources sufficient to meet 100 years of demand, at today's production levels.

However, a number of challenges need to be met before this theoretical potential can be converted to available and affordable natural gas production:

1. Build confidence in adequate and robust natural gas supplies.
2. Assure affordable future natural gas prices and underlying costs.
3. Address environmental barriers to natural gas development.
4. Increase demand for natural gas in a "carbon constrained" world.

# Challenge #1. Confidence in Adequate and Robust Natural Gas Supplies

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Considerable skepticism still exists on the abundance of domestic natural gas supplies.

- Pronouncements that we are “running out of natural gas supplies”, voiced by the Federal Power Commission and H. King Hubbert in the 1970s, led to legislative constraints on natural gas use.
- Just 5 years ago, the Chairman of the Federal Reserve, Alan Greenspan, called for the U.S. to aggressively pursue LNG to avoid shortages.
- CERA’s publications in 2006/2007 entitled “Diminishing Returns”, citing lack of supply response to increased drilling, advised that even at natural gas prices of \$10/Mcf, the U.S. could not sustain production capacity.
- Numerous analysts and observers still view that we are merely on a natural gas supply treadmill - - “you have to keep drilling like crazy just to stay in one place”.

# Challenge #1. Confidence in Adequate and Robust Natural Gas Supplies

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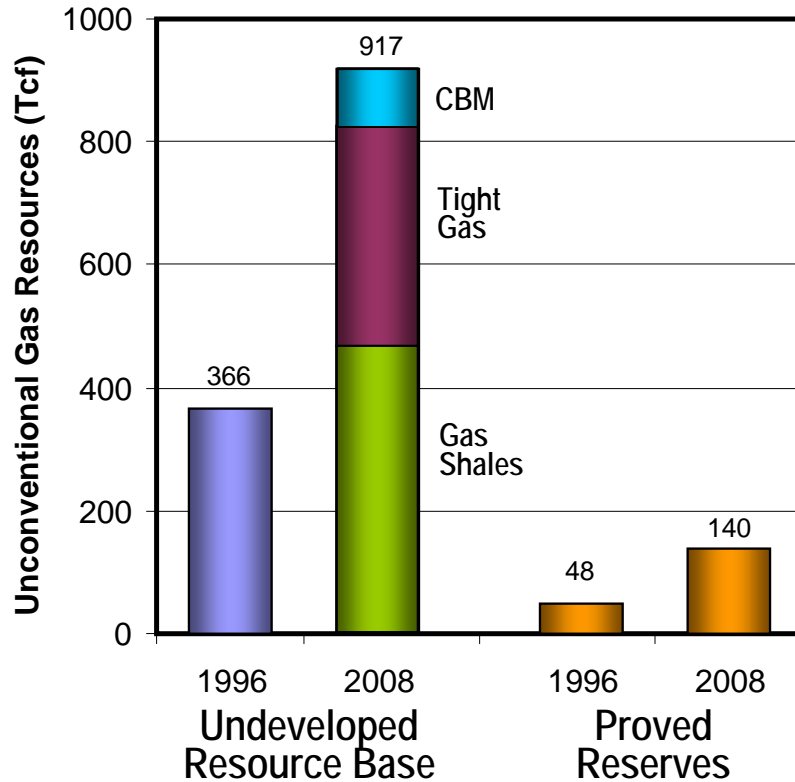
Recent studies indicate that the U.S. has large undeveloped supplies of natural gas:

- The Energy Information Agency reports 1,770 Tcf of technically recoverable natural gas.
- The Potential Gas Committee estimates remaining U.S. natural gas resources at 2,070 Tcf.
- Comprehensive basin and play level studies by our firm (Advanced Resources) support a robust outlook for domestic natural gas supplies.

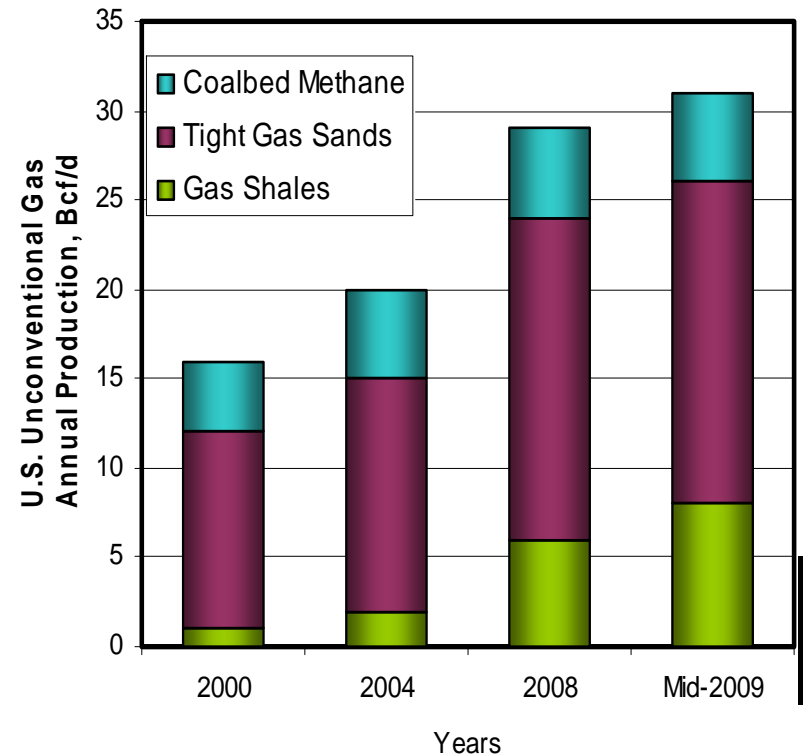
# U.S. Unconventional Gas Resources

Advances in geologic understanding and progress in extraction technology are behind the increase in the unconventional gas recoverable resources and their contribution to annual production.

**Advanced Resources' Estimate of Unconventional Gas Resources**



**Unconventional Gas Currently Provides Over Half of Domestic Production\***



\*Current U.S. natural gas consumption is about 62 Bcf.

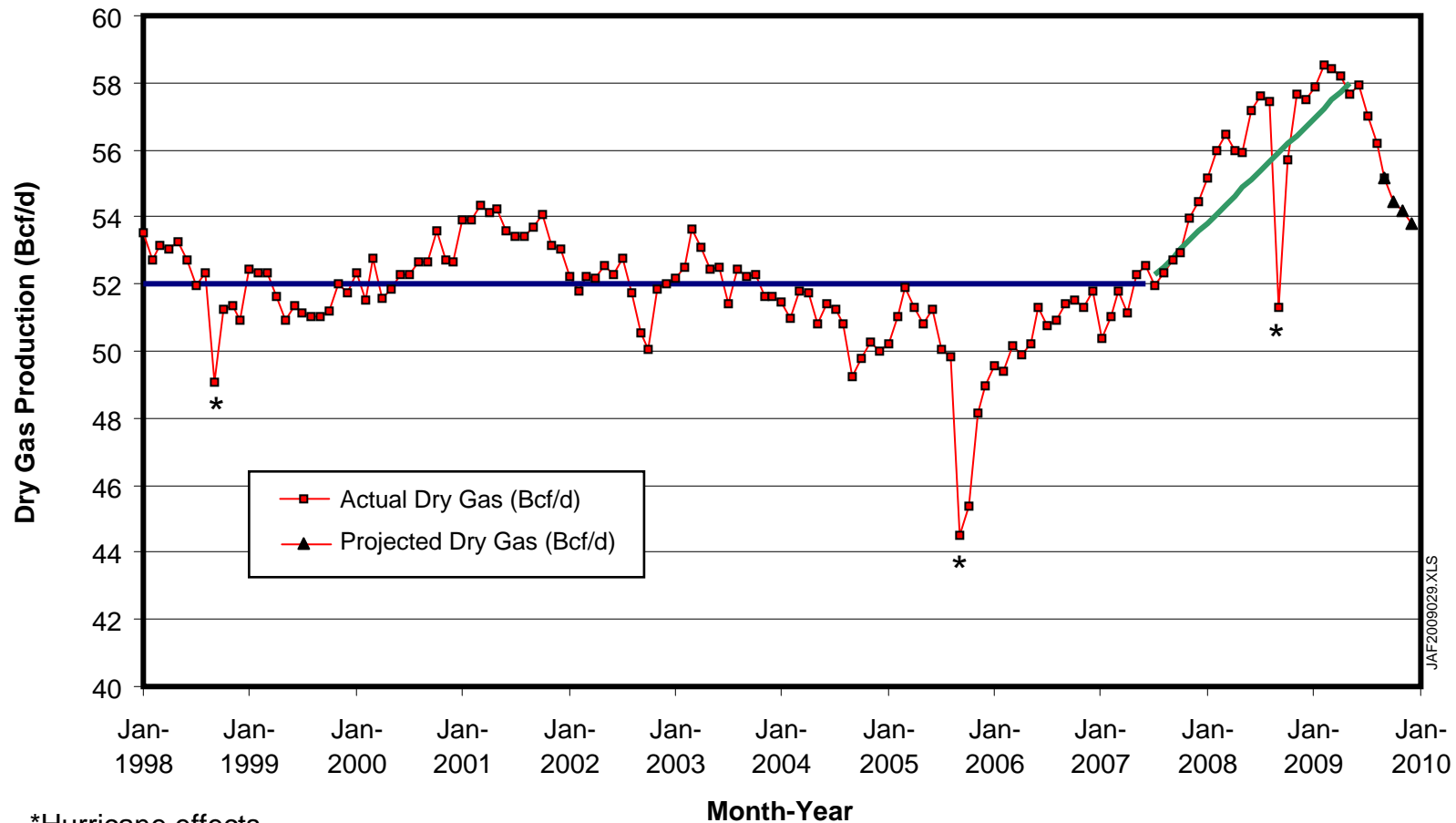
Source: Advanced Resources International (2009).

# Fayetteville Shale: Improving Well Performance

Longer laterals, more frac stages, and more intensive perforation clusters (plus 3-D seismic), have improved performance of Fayetteville Shale wells by nearly three-fold, driving down costs per Mcf.

Time Frame	Wells on Production	Average IP Rate (Mcf/d)	30 <sup>th</sup> Day Rate	60 <sup>th</sup> Day Rate	Average Lateral Length
1 <sup>st</sup> Qtr 2007	58	1,260	1,070	960	2,100
2 <sup>nd</sup> /3 <sup>rd</sup> /4 <sup>th</sup> Qtr 2007	197	1,770	1,490	1,290	2,500-3,190
1 <sup>st</sup> Qtr 2008	75	2,340	2,150	1,940	3,300
2 <sup>nd</sup> /3 <sup>rd</sup> /4 <sup>th</sup> Qtr 2008	244	2,920	2,480	2,210	3,720
1 <sup>st</sup> Qtr 2009	120	2,990	2,540	2,310	3,870
2 <sup>nd</sup> Qtr 2009	111	3,610	2,950	2,690	4,120

## After A Decade of “Running In Place”, Aggressive Pursuit of Unconventional Gas, Particularly Gas Shales, Has Led to Increased Production Capacity



\*Hurricane effects

Source: DOE-EIA Short Term Energy Outlook (August 2009)

## **Challenge #2. Affordable Future Natural Gas Costs and Prices**

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Many believe that the costs of unconventional gas development are high, making these supplies unaffordable.

Having been “bitten” before, industrial firms and utilities are concerned that after the current gas bubble is over, natural gas prices will rise to unaffordable levels.

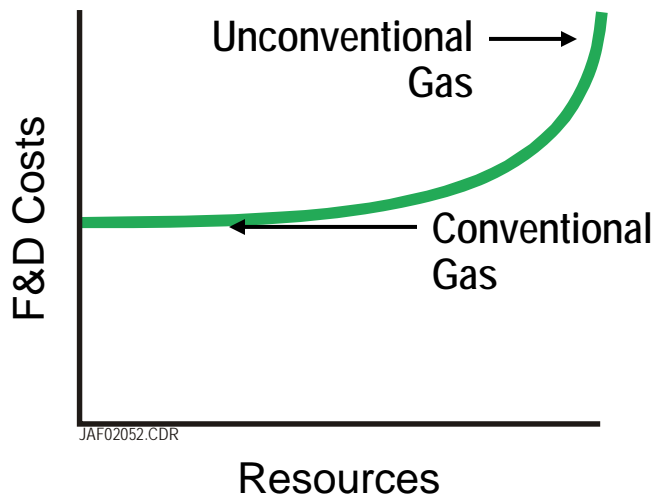
Increases in natural gas well costs and the natural gas price explosion of 2008, with natural gas prices of \$13/Mcf (Henry Hub spot, June, 2008) are cited as evidence.



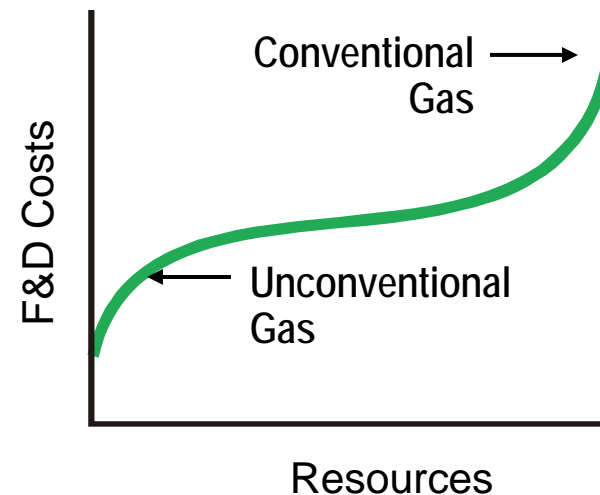
# The Paradigm Shift in Natural Gas Supply Costs

**Paradigm Shift.** A “paradigm shift” has occurred in natural gas supply costs. Unconventional gas and particularly gas shales are today the dominant source of supply and the low cost portion of the resource base.

## Prior Perception

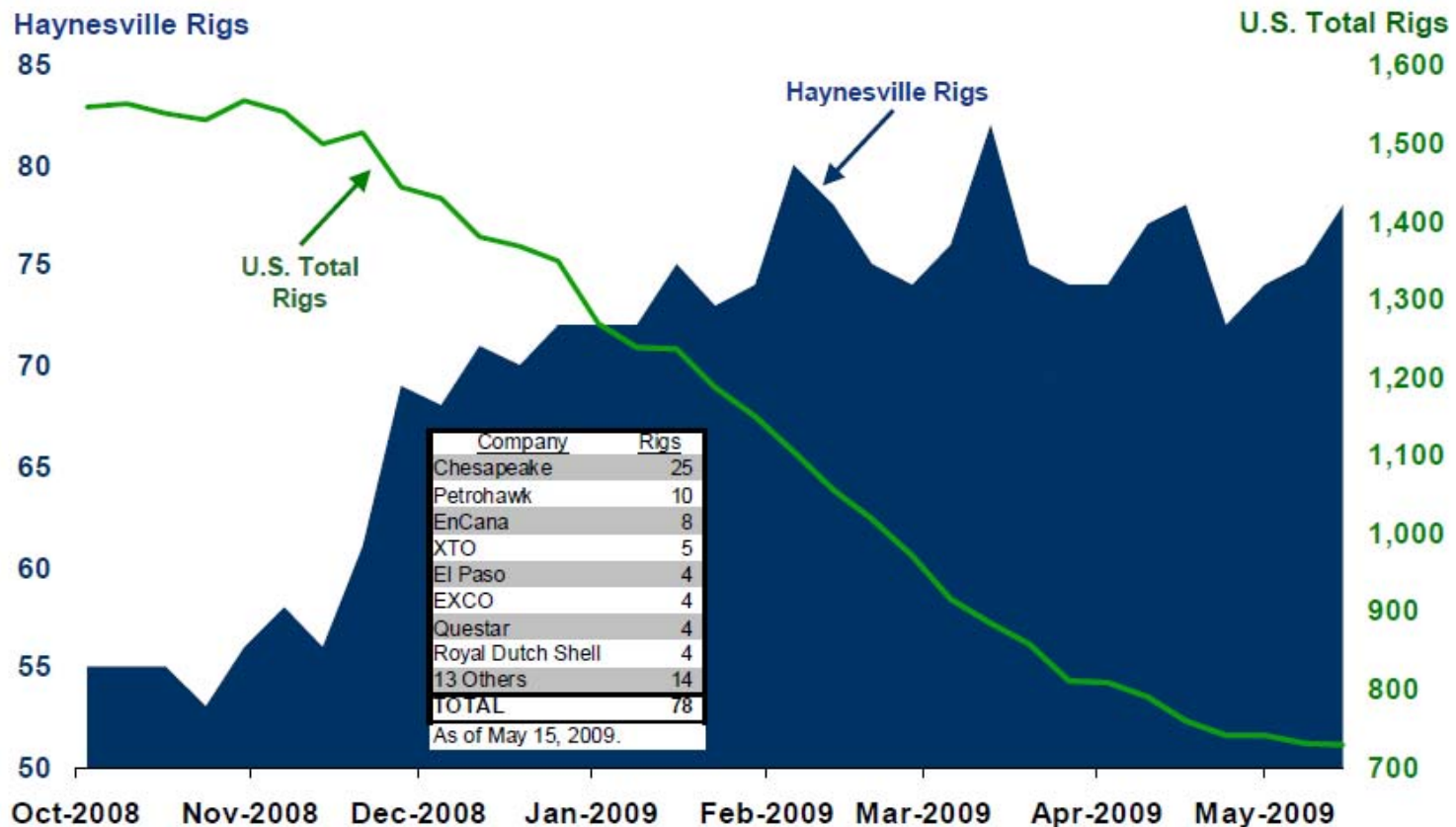


## New Understanding



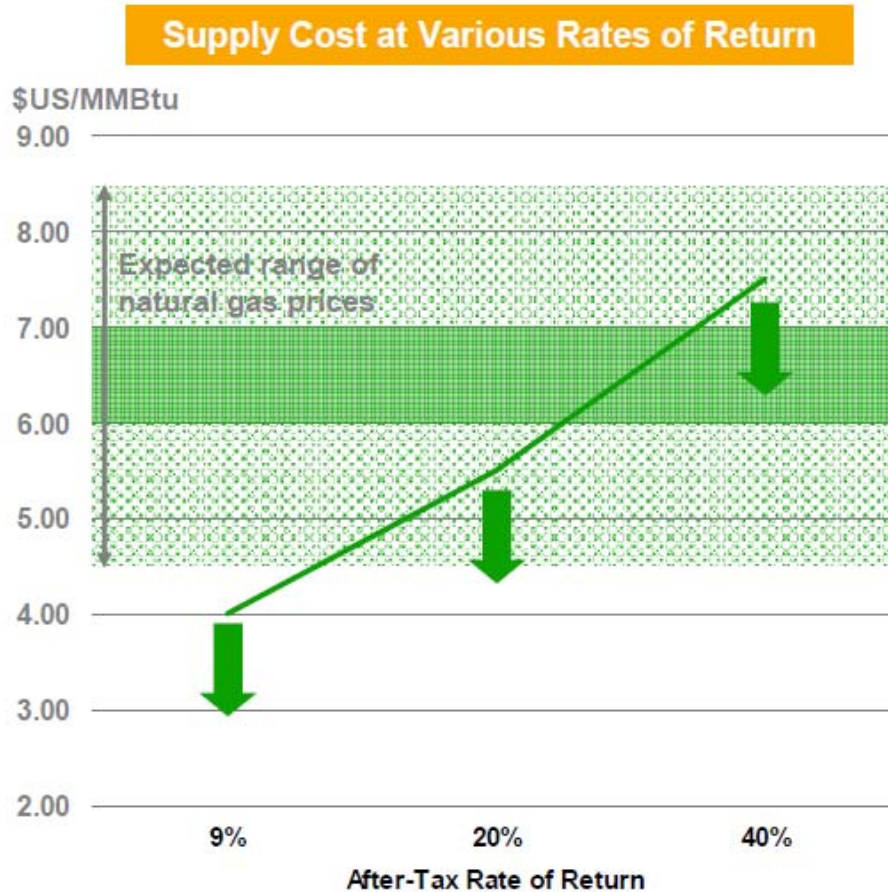
## Evidence for the Paradigm Shift

While total working U.S. natural gas rigs have declined by more than half, the rig count in the Haynesville area has remained strong, pushing Haynesville Shale production over 1 Bcfd.



Source: EnCana, 2009

# Unconventional Gas Supply Costs



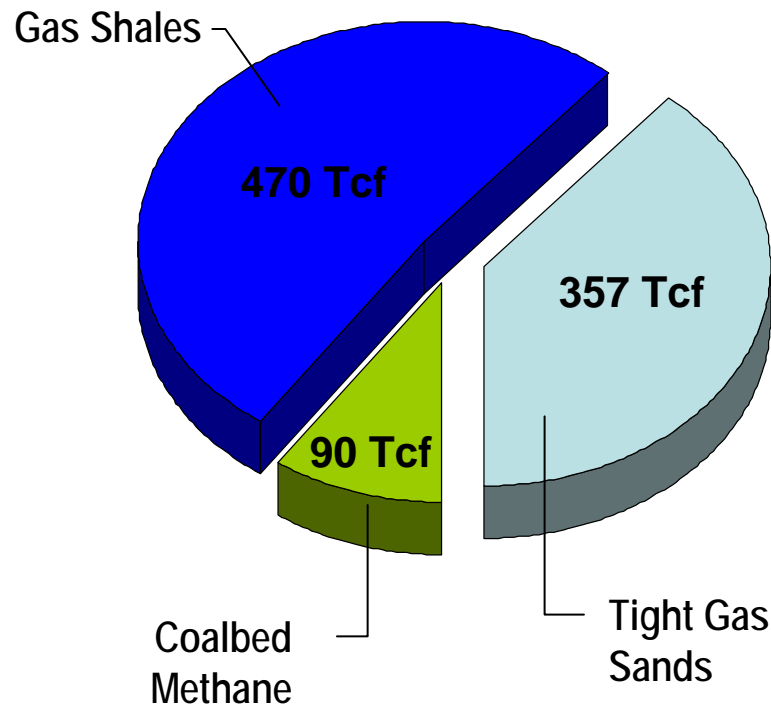
Source: EnCana (2009)

## *Producer Expectations*

- EnCana, North America's largest natural gas producer, expects long-term natural gas supply costs and prices of \$6 to \$7/MMBtu.
- Anadarko's CEO states that for its large Marcellus shale "the economics are good" at \$3/Mcf (NYMEX), (Oil and Gas Investor, August, 2009).

# However, Only a Portion of the Unconventional Gas Resource Base is “High Quality/Low Cost”

Continuing advances in science, geological knowledge and extraction technologies will be essential for converting the lower quality/higher cost resources to affordable natural gas supplies.



	Total Undeveloped	High Quality	Lower Quality
Gas Shales	470	209	261
Tight Gas Sands	357	173	184
Coalbed Methane	90	49	41
<b>TOTAL</b>	<b>917</b>	<b>431</b>	<b>486</b>

Source: Advanced Resources Int'l., 2009

## **Challenge #3. Addressing the Environmental Barriers to Greater Natural Gas Development**

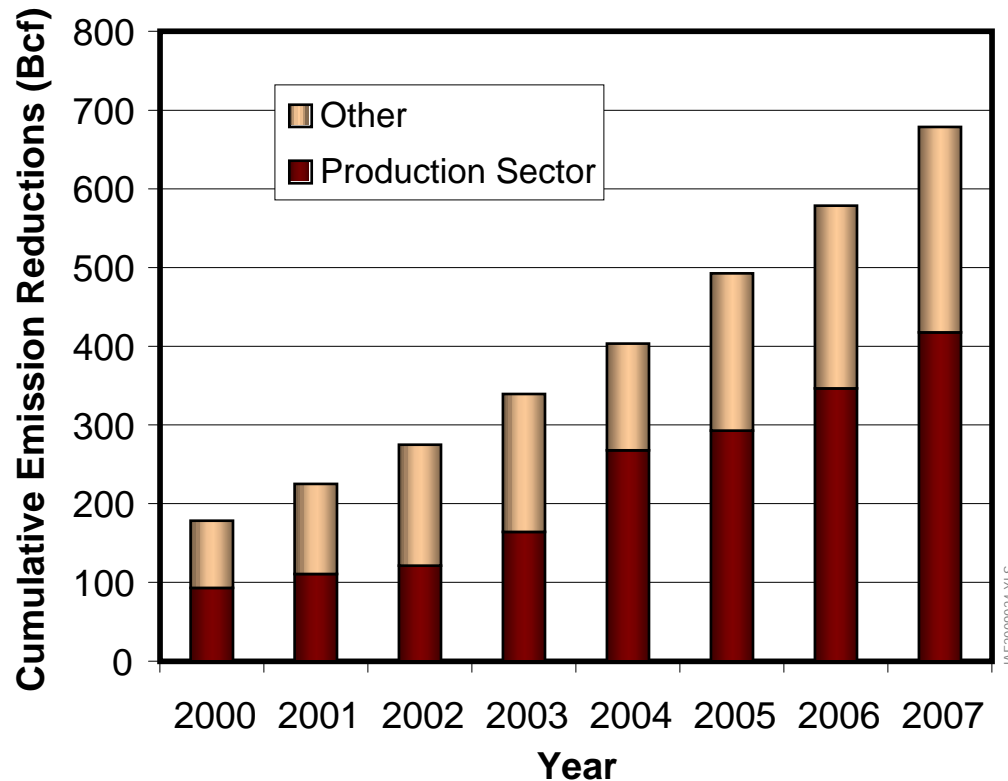
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As drilling increases and production grows, a harsher “spotlight” will fall on natural gas. “Green natural gas development” will help put a more environmentally friendly face on this activity.

- Capturing More Methane Emissions
- Further Reducing Surface Impacts
- Pursuing Safe Hydraulic Fracturing

# Voluntarily Reducing Methane Emissions

Cumulative Methane Emission Reductions by EPA Natural Gas STAR Partners (2000-2007)



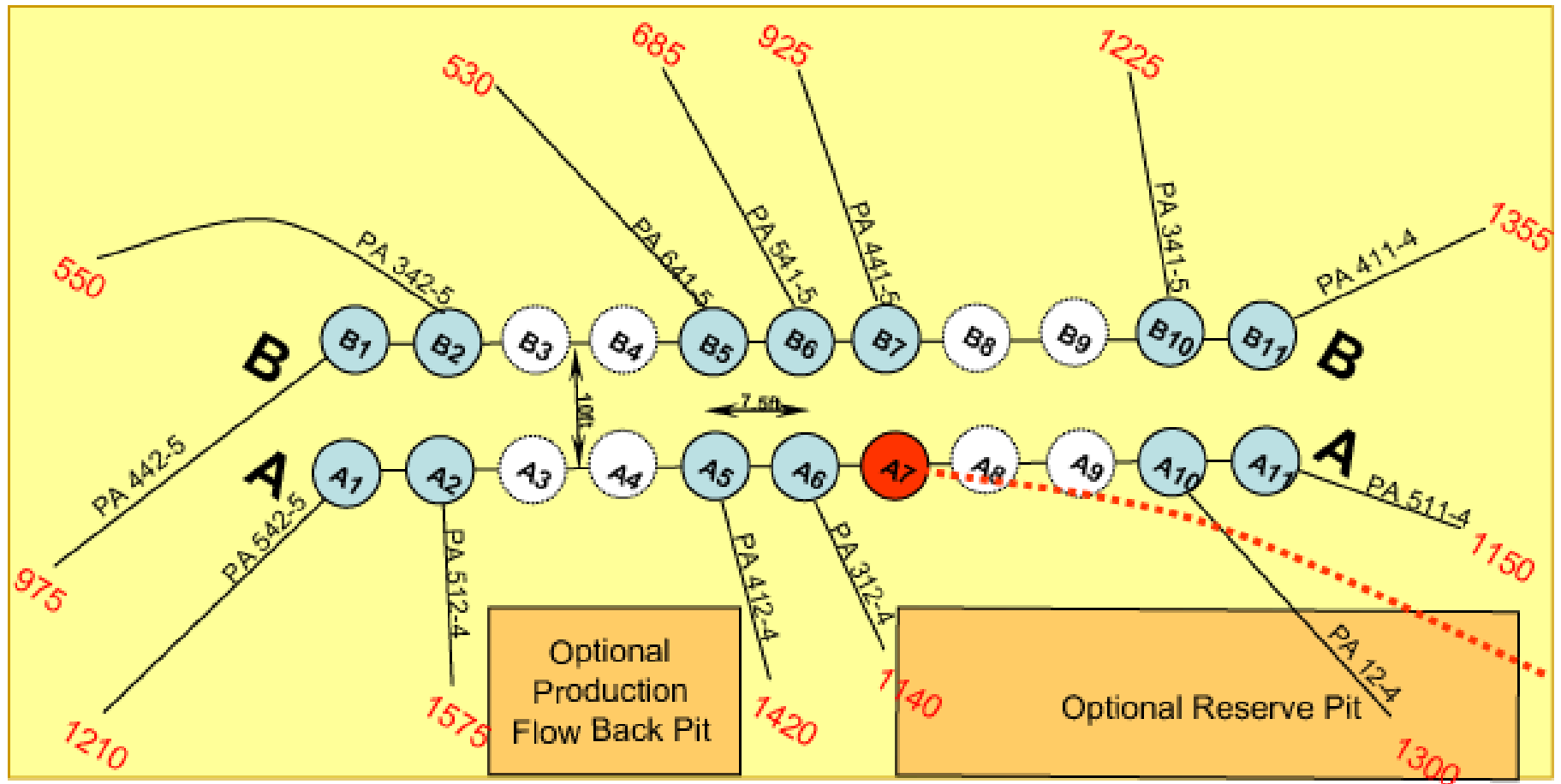
- Since 1990, Natural Gas Star partners have eliminated 417 Bcf of methane emissions from the oil and gas production sector.
- Williams reports 24 Bcf of methane emissions captured with costs of \$17 million and revenues of \$159 million.

Source: U.S. Environmental Protection Agency ([www.epa.gov.gasstar/accomplish.htm](http://www.epa.gov.gasstar/accomplish.htm))



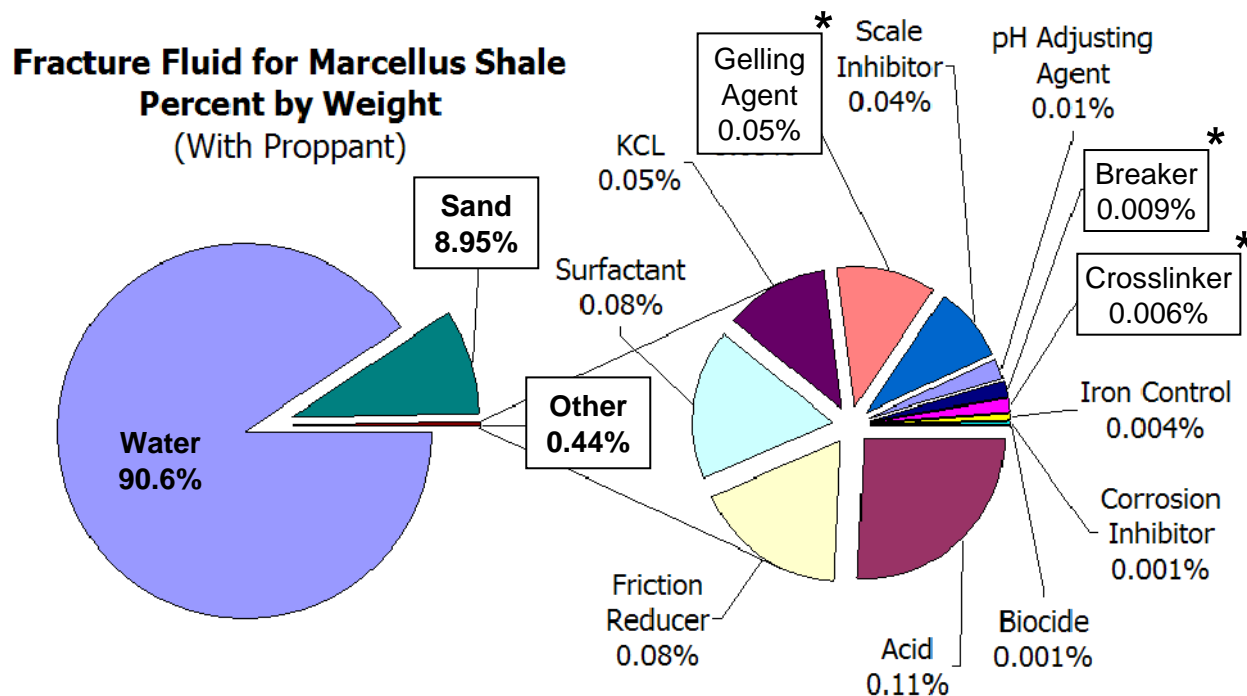
# Drilling Multiple (22) Wells From A Single Well Pad

(Williams Fork/MV, Piceance Basin)



Source: Williams, 2007

# Composition of Fluids, Chemicals and Materials in Hydraulic Fracturing Operations



**Acids:**  
Hydrochloric or muriatic acids; commonly used in swimming pools.

**KCl:**  
Food preservative; low sodium table salt.

**Surfactants:**  
Used in shampoos, household detergents.

\*Eliminated in many fracturing operations.

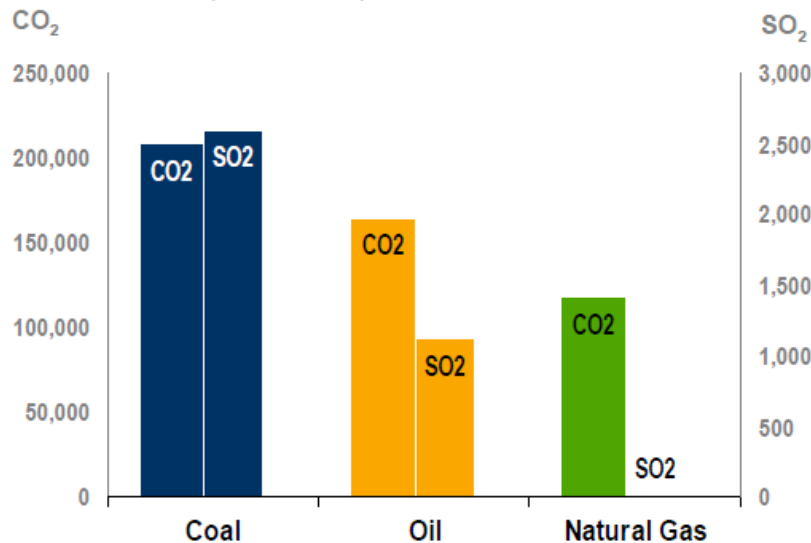
Source: Arthur, J. Daniel, et al., 2008.



## Challenge #4. Building Demand for Natural Gas in a Carbon Constrained World

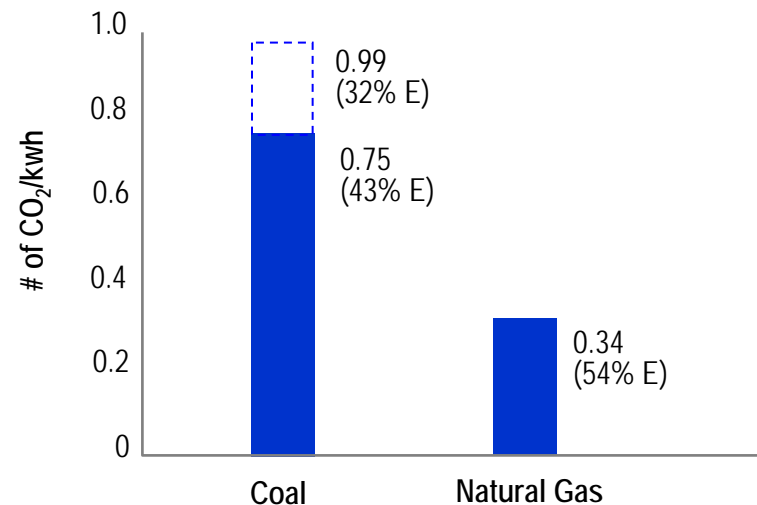
Natural gas is a relatively “clean fuel” with lower emissions of CO<sub>2</sub> and SO<sub>2</sub> than coal or oil. Still, producing and using natural gas contributes to overall emissions of greenhouse gases.

CO<sub>2</sub>/SO<sub>2</sub> Emissions Levels by Fuel Type (lbs/BBtu)



Source: EnCana 2009

CO<sub>2</sub> Emissions Levels for Electricity (lbs/kwh)



## **Challenge #4. Building Demand for Natural Gas in a Carbon Constrained World**

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A number of actions, some hopefully introduced in legislation and some undertaken by industry, would help build natural gas demand.

### ***Legislative Actions and Initiatives***

1. Provide incentives and/or tax credits for integrating natural gas with intermittent renewable energy for power generation.
2. Expand the market for natural gas by providing incentives for gas-powered fleets, buses and heavy trucks.
3. Support research and deployment of carbon capture and storage (CCS) for natural gas-fired power generation.
4. Support research toward a 60+% efficient natural gas-fired combined-cycle plant, reducing CO<sub>2</sub> emissions to below 0.3 lbs/kwh.

# Challenge #4. Building Demand for Natural Gas in a Carbon Constrained World

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## *Industry Actions and Initiatives*

1. Undertake industry-wide initiatives to further reduce methane and CO<sub>2</sub> emissions during production and transportation; “a win-win for everybody” (Devon Energy).
2. Pursue “green development” as standard “best operating practices” for natural gas drilling, testing and production.
3. Support research and technology investments, including collaborative private-public initiatives, for reducing the future natural gas supply cost curve.



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